CLDP Human Systems Integration Workshop

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COMMERCIAL LEO DEVELOPMENT PROGRAM

Maintainability and Supportability
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Purpose of Maintainability and Supportability

- NASA policy addresses the need for agency-funded programs and projects that develop or procure reusable or maintainable flight hardware or programmatic / mission-specific ground hardware to define and implement measures that provide life-cycle support to increase the probability of mission success and to control and reduce life-cycle costs and risks.
- Ensuring affordability starts at the earliest phases of a system's life cycle, where decisions drive acquisition costs and essentially lock in operations and support costs. Decisions made up front during the early phases from program inception have a profound effect on life cycle cost.
- The purpose of Supportability and Maintainability engineering is to influence system design to increase mission capability and availability and decrease logistics burden and cost over a system's life cycle. Supportability and Maintainability are an integral part of the systems engineering process.

Planning early to support and maintain a system lowers costs and increases mission success.

Definitions

- Supportability is the capability of a total system design to support operations and readiness needs throughout the system's service life at an affordable cost. It provides a means of assessing the suitability of a total system design for a set of operational needs within the intended operations and support environment (including cost constraints).
- Maintainability is the probability that a failed component or system will be restored or repaired to a specified condition within a specified period or time when maintenance is performed in accordance with prescribed procedures.
  - Maintainability must be designed-in early in the process to provide effective troubleshooting and repair capabilities at all levels of indenture.

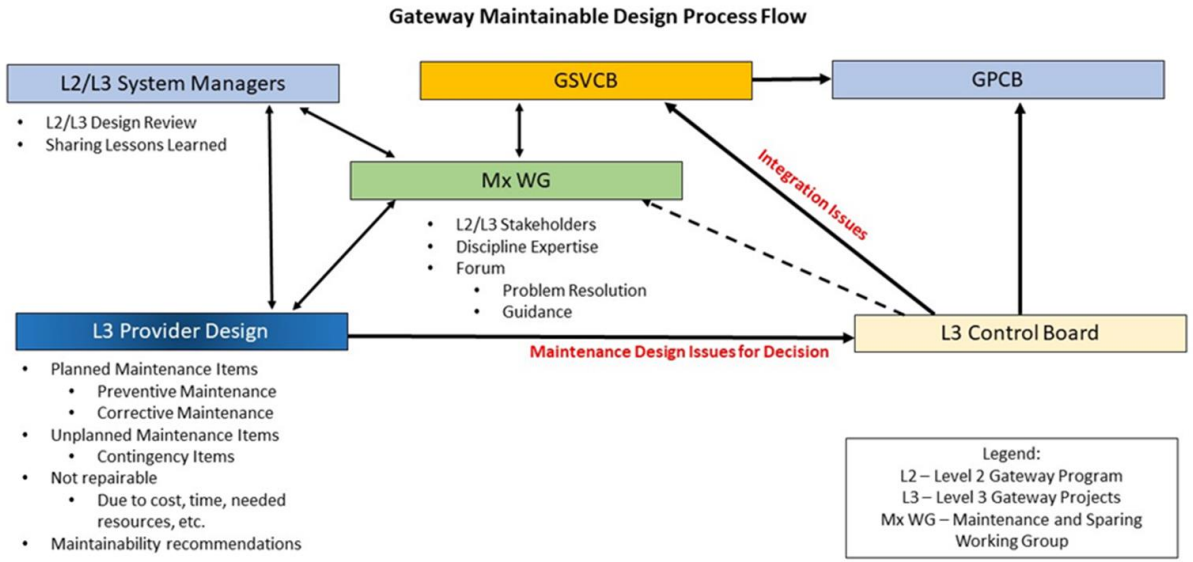
> System design determines how easy and cost effective it is to fix and run, and needs to predict how the system might break, and how breaks can be fixed.

Gateway Maintenance Philosophy

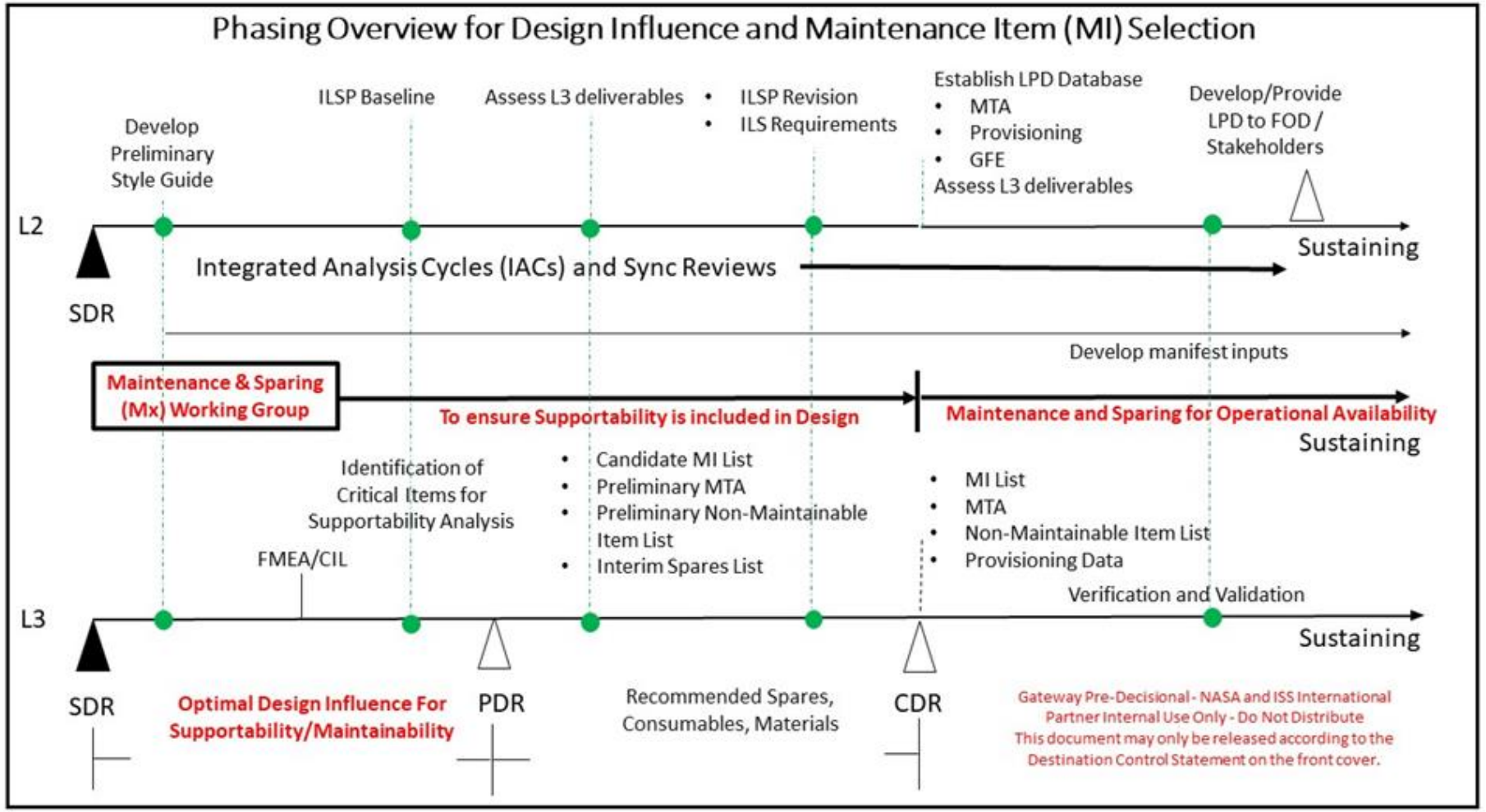
- The Maintenance Design Influence Process is accomplished through inclusion of supportability and maintainability as part of the system's design characteristics from program inception, where the goal is to design hardware to be as reliable and robust as possible, but also allowing for both preventive and corrective maintenance, so Gateway can meet and exceed it's 15-year life.
  - This process is used to ensure that critical systems are maintainable while balancing the impacts of maintenance (upmass, crewtime) with system complexity and cost.
  - The Maintenance Design Influence Process reviews the design data supplied by the L3 developers to the L2 program, based on maintainability requirements and maintenance and supportability criteria. Recommendations are then supplied back to the L3 providers for design updates to improve maintainability and supportability of the systems.
  - The primary forum for this approach is the Maintenance and Sparing (Mx) Working Group using the process and criteria detailed in GP 10050, Integrated Logistics Support Plan (ILSP), Revision D, authored by the ESSCA Integrated Logistics Support (ILS) team at MSFC.

Gateway Maintenance and Sparing Working Group

- The Mx WG serves as a forum to facilitate and integrate design, logistics, maintenance, and sparing activities to ensure supportability and considerations for service life beyond 15 years across Gateway.
- Primary responsibilities of the MxWG include, but are not limited to the following:
  - Influence the design for maintainability in conjunction with NASA Human Systems Integration (HSI) Maintainability and Supportability Domain, and other stakeholders
  - Provide L2 guidance/insight on requirements, concepts, and design considerations for preventive, corrective and contingency maintenance as well as consideration for potential service life extension
  - Assess L3 design, logistics, and maintenance plans to ensure L2 maintenance concepts and requirements are met
  - Facilitate transition of maintenance and sparing activities from design phase through operations
  - Provide a forum for resolving supportability issues affecting multiple Gateway elements.



Gateway Life Cycle Design Influence Engagement



Planning for maintenance is an iterative process that occurs throughout project life cycles.

Gateway Maintenance Documentation

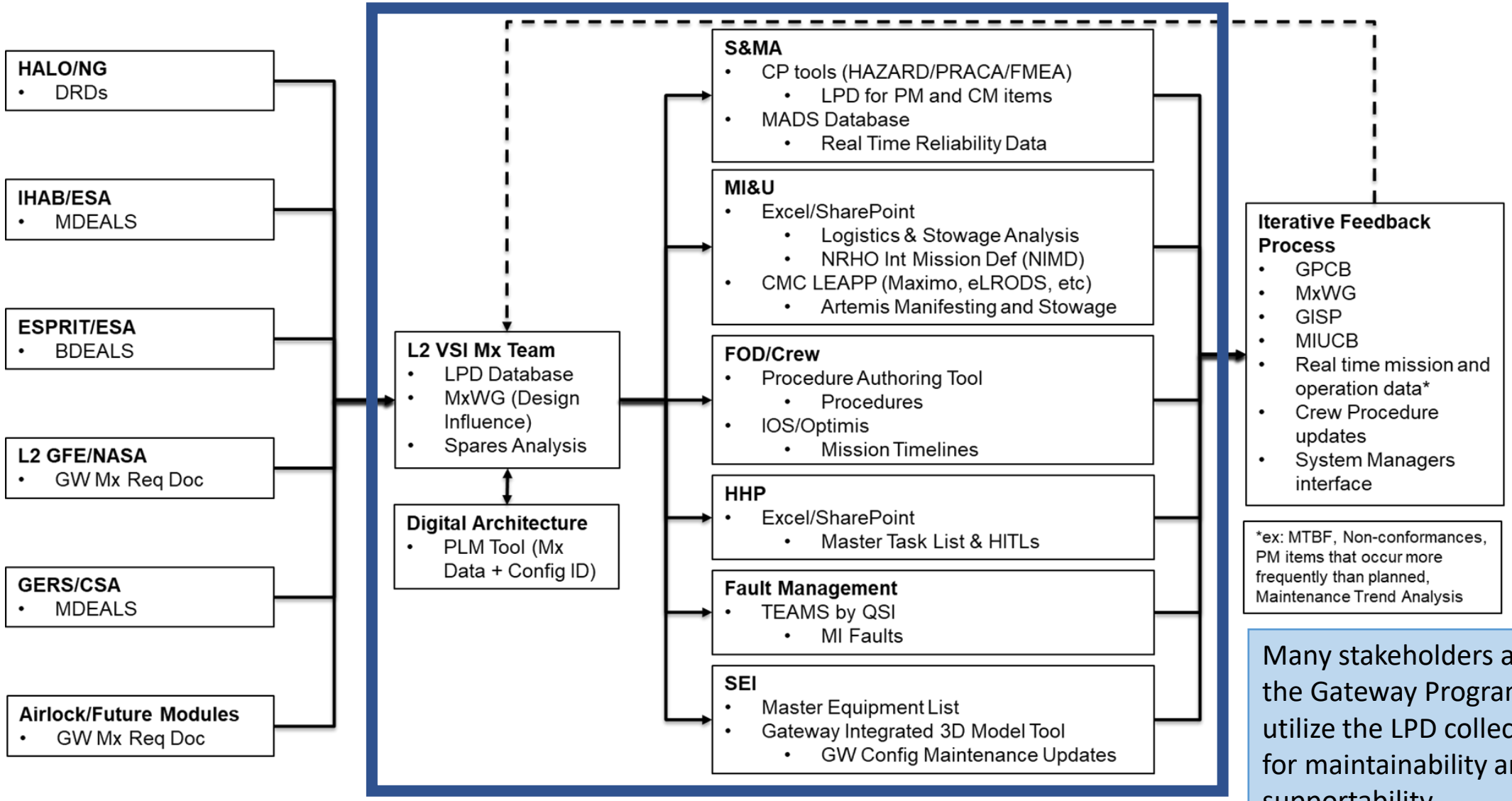
- **Gateway Integrated Logistics Support Plan, GP 10050,** provides guidance for design of supportable modules, systems, and GFE projects for maintenance, logistics, and sparing philosophies to ensure a sustainable Gateway and supportability for mission operations, includes:
  - Supply Support: ensure that all parts, spares, support and test equipment, and other maintenance resources are available for Gateway operations. Includes obsolescence considerations.
  - Packaging, Handling, Storage, and Transportation (PHS&T): plans, processes, and requirements ensure that Gateway equipment, material, and support items are preserved, packaged, marked, handled, transported, and stored properly for short- and long-term needs.
- **Maintenance and Sparing Requirements Document, GP 10171,** defines the Logistics Product Data (LPD) deliverable requirements, support documentation and data sets needed by the program from the Gateway elements/modules/GFE projects for maintenance and supportability.
  - This LPD is the Authoritative Source for Gateway Mx data and is captured in the LPD database, SLICwave.

Documentation providing guidance on design influence and contract mechanisms to collect spares provisioning and maintenance data for supportability are essential.

Gateway Logistics Product Data Database

- **Logistics Product Data (LPD) Database:** GW Mx Team will use the SLICwave Lifecycle software as the primary tool for the collection, integration, and distribution of LPD providing the ability to integrate Sub-Element LPD into a consolidated logistics support picture for Gateway.
  - Compliant with the national standard for Logistics Product Data, GEIA-STD-0007, (compatible with S-Series International Standards and International Organization for Standardization (ISO) 10303-239 Product Life Cycle Support).
  - Uses Extensible Markup Language Schema Definition (XSD) as primary method to exchange data with other systems. Also capable of exchanging data via XLSX and XLS Microsoft Excel Spreadsheet and Fixed Format (columnar) text.
  - The LPD database provides a digital platform giving insight into the parts, pieces, materials, and processes required to maintain and sustain Gateway.
- **Example categories of data provided by Modules and GFE Projects to inform LPD Database:**
  - Supportability analysis and MTA results for preparation of crew preventive and corrective maintenance procedures, includes task narrative step description, estimated completion time, personnel, tools, support equipment, and materials required.
  - Provisioning data for parts list and sparing recommendations for Maintenance Items (MIs) and associated tools, support equipment, and consumables
  - Static Parts and Packaging Data
  - Maintenance Plans and Concept
  - Metrics for operational phase maintenance trend analysis, operational availability

Maintenance and Sparing Tools/Data Flow



Many stakeholders across the Gateway Program utilize the LPD collected for maintainability and supportability

Gateway Design Influence Success Stories

- European System Providing Refueling Infrastructure and Telecommunications (ESPRIT) Maintainability
  - Re-design to allow for internal avionics maintenance
- Habitation and Logistics Outpost (HALO) Virtual Reality (VR)
  - Adjusted component locations after utilizing VR capabilities for ease of accessibility and maintenance
- International Habitat (IHAB) External Thermal Control System, Battery
  - Iteratively engaged with ESA to provide maintainability recommendations via the Mx WG that were incorporated
- HALO Lunar Communication Subsystem (HLCS) Contingency Maintenance
  - Highly reliable, critical, but non-maintainable system. Provided recommendations to ESA on potential ways to account for future maintenance, if ever required, that were incorporated into their design

Backup